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ON GEOSPATIAL INFORMATION and SERVICES

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Joint Military Operations Department.

The Contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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The term geospatial information and services (GI&S) has replaced the term mapping, charting and geodesy (MC&G) throughout military doctrine. More than just a digital map, geospatial information is a key enabler of information superiority. It is the reference framework within which other data can be fused, analyzed and visualized to provide dominant battlespace awareness in support of planning, decision making and operations. The potential of GI&S to support tactical level tasks has been successfully demonstrated in recent events including Operation ALLIED FORCE and JWID00. However, the potential contribution to operational level tasks has not yet been realized. The key to realizing the full potential of GI&S lies not in the data or the tools to manipulate it, but in the expertise of the individuals trained in GIS. Including these people in the deliberate and crisis action planning process is the first step toward realizing the potential contribution of GI&S at the operational level.

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On Geospatial Information and Services

"Know the enemy, know yourself; your victory will never be endangered.
Know the ground, know the weather; your victory will then be total."

Sun Tzu, The Art of War
C. 500 B.C.

Introduction

The term geospatial information and services (GI&S) [1] has replaced the term mapping, charting and geodesy (MC&G) throughout military doctrine. "This change was necessitated by an increasing use of digital geospatial information to perform many military functions such as navigation, mission planning and mission rehearsal, targeting, and analysis of the battlespace." [2] Unfortunately, the significance of this change in terminology has eluded many of those who could derive some benefit from it. More than just a digital map, geospatial information is a key enabler of information superiority. It is the reference framework within which other data can be fused, analyzed and visualized to provide dominant battlespace awareness in support of planning, decision making and operations. It is the thesis of this paper that an increased awareness and better understanding of the capabilities of GI&S will significantly aid the operational commander.

The environment today is one in which commanders must make decisions within compressed timelines, on a full spectrum of force engagement options, at all levels of operations

[1] Joint Chiefs of Staff, Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations, Joint Pub 2-03 defines geospatial information and services as "The concept for collection, information extraction, storage, dissemination, and exploitation of geodetic, geomagnetic, imagery (both commercial and national source), gravimetric, aeronautical, topographic, hydrographic, littoral, cultural, and toponymic data accurately referenced to a precise location on the earth's surface. These data are used for military planning, training, and operations including navigation, mission planning, mission rehearsal, modeling, simulation and precise targeting. Geospatial information provides the basic framework for battlespace visualization. It is information produced by multiple sources to common interoperable data standards. It may be presented in the form of printed maps, charts and publications; in digital simulation and modeling databases; in photographic form; or in the form of digitized maps and charts or attributed centerline data. Geospatial services include tools that enable users to access and manipulate data, and also include instruction, training, laboratory support, and guidance for the use of geospatial data. Also called GI&S."

[2] Joint Chiefs of Staff, Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations, Joint Pub 2-03, (Washington, DC: 31 March 1999), I-1.

and war. The ability to fuse data and visualize information greatly facilitates that decision making process. While some information has no geospatial context whatsoever, a majority of data can be referenced to a particular location on the Earth and can be interpreted in a geospatial context much more easily than from a spreadsheet or textual report. GI&S provides the capability to perform the analysis and visualization of geospatial data, thus enabling better decision making.

Advancements in technology continue to improve the ease with which geospatial data fusion and visualization are accomplished. Commercial geographic information systems (GIS) available today have increasingly better capabilities to ingest, manipulate, display, and output information. The capabilities of government tools inevitably lag those of commercial, off-the-shelf (COTS) solutions, but the trend toward commercialization of government mapping applications suggests the closing of that gap.

The vision of full spectrum dominance enabled by information superiority and evidenced through a common operational picture is the promise of tomorrow, but the basic capabilities exist today. As commanders gain awareness and understanding of the full scope of GI&S capabilities, additional requirements will undoubtedly be revealed and the evolution toward full spectrum dominance will continue. The more commanders understand about GI&S today, the more likely the capabilities developed for tomorrow will reflect their desires.

This paper is not about tomorrow's capabilities. It is intended to raise the awareness of operational commanders concerning the GI&S capabilities that exist today, and suggest how they may be used to facilitate the planning process. In the course of raising awareness, "On Geospatial Information and Services" will examine three key components of GI&S, data, tools and people, which are fundamental to the proper employment of this capability.

On Data

Data are the fundamental building blocks of understanding. Raw data has very little meaning until it is processed in some way and becomes information. Knowledge results from analyzing, correlating, and fusing the information, which helps to build a picture of the situation. Finally, by applying judgment, we transform knowledge into understanding. Understanding equates to situational awareness, through which we can see patterns emerging from events in the battlespace and anticipate the consequences both of our actions and those of the enemy.[3]

The Reference Framework

GI&S data can come from any number of sources. NATO defines "any entity whose position is referenced to the Earth" as geospatial data.[4] By this definition, a spreadsheet of targets, a textual order of battle description, a database of airfields, or a global positioning system (GPS) coordinate are all examples of geospatial data. Any of these examples, when viewed in the context of a spatially referenced framework, becomes geospatial information.

The spatially referenced framework is typically a map, an image, an elevation model, or any combination of the three. The National Imagery and Mapping Agency (NIMA) is the primary supplier of this framework at the strategic, operational and tactical levels. At the strategic level, a worldwide requirement exists for low-resolution elevation, feature and imagery databases, and NIMA is working this requirement primarily through contracts with the private sector. At the operational and tactical level, where greater detail and accuracy are necessary over smaller geographic areas, mission specific requirements exist. A listing of all requirements for GI&S is found in Annex M of Operations Plans (OPLANS) and Concept Plans (CONPLANS).

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[3] Navy Department, Naval Command and Control, Naval Doctrinal Pub 6, (Norfolk, VA: 19 May 1995), 20-23.

[4] North Atlantic Treaty Organization Military Agency for Standardization, NATO Glossary of Terms and Definitions, (Brussels: September, 1998), 2-G-1.

It is typically the responsibility of the GI&S officer of a unit or command to ensure that Annex M is complete and to identify shortfalls if and where they exist. In the days of MC&G, Annex M was a list of standard NIMA products required to support operations over a specified geographic area. In today's world of GI&S, Annex M should include much more. No doubt, standard products like 1:50K Topographic Line Maps, 1:250K Joint Operations Graphics, Digital Terrain Elevation Data (DTED) and Controlled Image Base (CIB) are still required for mission success and should still be included in Annex M. But thinking in terms of data, vice products, is the key to realizing the full potential of GI&S. The GI&S officer, in conjunction with the likely JTF commander for each plan, needs to think about what types of decisions can be facilitated by the analysis and visualization of geospatial data, and include requirements for those datasets and the supporting analysis in the annex. A later section on GI&S applications will suggest some specific decision making cycles that could be facilitated by the analysis and visualization of geospatial data.

NIMA is not the only source of geospatial data. Universities, industry, other government organizations, military organizations, and foreign governments are other potential geospatial data producers. Ultimately, a distributed architecture will transparently link geospatial data holdings so users do not need to search for data. In today's world, however, finding data often requires experience and perseverance.

A Word of Caution

Understanding the characteristics of data is critical for the analysis of the information to be meaningful. It is essential to recognize that all geospatial data is not created equal. Variations in scale, accuracy, format, datum, projection, and coordinate system are common. This information is referred to as the metadata, or data about the data. Fusing information is only meaningful if the

metadata are understood and properly accounted for. Like statistics, geospatial data can be manipulated to provide different results. Understanding this potential will go far toward avoiding geospatial data abuses, which can lead to bad decisions.

On Exploitation Tools

Advances in technology are rapidly improving the tools available to exploit geospatial information. Predictably, government applications lag those of the commercial sector, but improvements are on the horizon. Ultimately, web based applications will provide intuitive interfaces to geospatial information and collaborative computing will enable virtual support to any user. This paper will remain focused on the tools available today that provide geospatial information exploitation capabilities.

GCCS/COP/JMTK

Perhaps the most familiar tool for displaying geospatial information is the Common Operational Picture (COP) within the Global Command and Control System (GCCS). The COP is built on a foundation of geospatial information that displays the disposition of friendly, neutral and adversary forces across the joint battlespace.[5] "The real value of the COP is in displaying battlespace information in a graphical manner that links to detailed information that similar reports such as [situation reports] SITREPs and [operation reports] OPREPs are unable to display." [6]

NIMA manages an Exploitation Tools Program that sponsors, among other tools, the Joint Mapping Tool Kit (JMTK), a government, off-the-shelf (GOTS) package that enables geospatial data exploitation within the COP. "JMTK is a software developer's toolkit containing common support application programmer interfaces within the Defense Information

[5] Joint Chiefs of Staff, Doctrine for Intelligence Support to Joint Operations, Joint Pub 2-0, (Washington, DC: 9 March 2000), II-13.

[6] Joint Chiefs of Staff, Doctrine for Logistic Support of Joint Operations, Joint Pub 4-0, (Washington, DC: 6 April 2000), I-18.

Infrastructure/Common Operating Environment (DII/COE). It provides the functions necessary to render a common view of the battlespace by standardizing the import, manipulation, and display of digital geospatial information." [7] Other exploitation tools managed by NIMA include Ruler, MATRIX, Multi-Image Exploitation Toolkit (MET) and Multi-Source Intelligence Toolkit (MINT), although these tools are used primarily to support imagery exploitation.

The tradeoff with any software application is between complexity and capability. The JMTK is a fairly simple application that performs the basic functions of loading, navigating and displaying geospatial data fairly well. However, it has almost no capability to perform the level of geospatial analysis that commercial software packages are capable of today. For example, it can not import anything but NIMA standard products, it does not support a scripting language, it does not support 3-D visualization, it does not allow data to be manipulated or modified, and there is a very limited hardcopy output capability. NIMA's goal is to fully commercialize the GIS portion of JMTK by 2004.[8] That effort should result in a much more capable tool, albeit somewhat more complex to operate. Not surprisingly, today's commercial GIS applications take a considerable amount of training for operators to become proficient, and continued use to remain so. A later section on people will explore where that expertise exists today.

Commercial Geographic Information Systems

COTS tools that perform geospatial data analysis are found under the broad heading of Geographic Information Systems (GIS). There are dozens of companies that market GIS applications. Among the global leaders are ESRI, ERDAS, MapInfo and Intergraph. By definition a GIS is "A system of computer software, hardware and data, and personnel to help

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[7] National Imagery and Mapping Agency, The FY 2003-2007 United States Imagery and Geospatial Information Service (USIGS) Functional Manager's Guidance (FMG), October, 2000, 19.

[8] Ibid.

manipulate, analyze and present information that is tied to a spatial location." [9] A sample of the common functions these systems perform includes spatial measurements, data integration, information retrieval, spatial interpolation, buffering and corridors, network analysis, map projection, registration and warping, terrain analysis, perspective scene generation and fly-throughs. All of these functions have practical application in the planning and conduct of military operations.

COTS Inclusion in the DII COE

One concern regarding the use of COTS tools in the DoD is for their integration and interoperability within the existing Defense Information Infrastructure Common Operating Environment (DII COE). "DII is a Defense Information Systems Agency (DISA) and Office of the Secretary of Defense for Command, Control, Computers and Intelligence (OSD(C3I)) approach for building interoperable systems with a collection of segmented software components."[10] "The DII COE provides an architecture of standards and reusable software to facilitate system development and simplify user access to multiple applications through common hardware."[11]

The logic behind the DII COE is sound, however, it is not conducive to the rapid insertion of developing technology. COTS products being considered for inclusion in the COE are evaluated against ease of use, architectural compatibility, requirements satisfaction, system resource requirements, integration impacts, and product maturity criteria. Most COTS products do not satisfy these criteria out-of-the-box, and GIS applications are no exception. Commercial

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[9] "Geographic Information Systems", <http://www.gis.com>, [07 January 2001], slide 4.

[10] Joint Chiefs of Staff, Global Command and Control System (GCCS) Functional Requirements Evaluation Procedures, CJCSM 6721.01, (Washington, DC: 15 March 1997), A-5.

[11] Defense Science Board, "Command, Control, Communications, Computers, Intelligence, and Reconnaissance" <http://www.dtic.mil/execsec/adr97/chap23.html>, [18 December 2000].

vendors must either modify their product, generally synonymous with stripping capabilities, to meet compliance specifications, or the government development and integration communities must develop GOTS components to wrap the COTS products to achieve the stated requirements. The process is time consuming either way and can result in a capability that is inferior to the original product. The fact that a COTS product is not part of the DII COE should not prohibit its use in an operational environment. A spiral integration process should work toward DII COE compliance, but the capability should be available in the meantime. DII COE compliance should be a goal, not a prerequisite, for the operational integration of commercial tools.

On People

The key to realizing the full potential of GI&S lies not in the data or the tools to manipulate it, but in the expertise of the individuals trained in GIS. Including these people in the deliberate and crisis action planning process is the first step toward realizing the potential contribution of GI&S at the operational level. All the complexities of geospatial data and software applications become transparent when a trained analyst is involved. Collaborative tools have already demonstrated that virtual expertise can be accessed when on-site personnel are not available. However, while the true potential of GI&S is still being discovered, there is no substitute for the interaction and dialogue achieved through physical presence.

Military Expertise

A limited degree of geospatial expertise exists in all of the services today. In the Army and Marine Corp, topographic battalions and platoons include individuals trained in GIS, as do some elements of Unified Command Joint Intelligence Centers (JICs) and Joint Analysis Centers (JACs). The Navy has some geospatial expertise, usually associated with the meteorological and

oceanographic (METOC) community. Air Force expertise is sprinkled throughout the service. These individuals are key to translating mission requirements and available data into relevant information.

There is also a GI&S officer assigned to most units and commands. "Given the increasing importance of geospatial information, and due to the complexity of production, dissemination, and exploitation, it is recommended that all echelons which employ operations and intelligence sections designate a command or unit GI&S officer."[12] Not all of these officers are trained in the use of GI&S tools, but they should have an understanding of the data and usually know where to find expertise if they do not possess it themselves.

Civilian Expertise

The bulk of the civilian intelligence community expertise in GI&S, supporting military operations, resides at NIMA. Although the majority of these people work at NIMA facilities in Washington, DC or St Louis, MO, there are Liaison Officers and Technical Representatives providing on-site support to all Unified Command headquarters and many of their components. There are currently 61 Technical Representatives, with plans to provide 5-8 more in FY 2001, deployed to customer sites around the world. These individuals are the true experts in tailoring geospatial information to support the full spectrum of military operations. They generally work in the intelligence or operations footprint.

During actual operations, additional GI&S expertise can be called for as part of a national intelligence support team (NIST). "At the request of the CINC, the [National Military Joint Intelligence Center] NMJIC may deploy a national intelligence support team (NIST) to support the Commander, JTF (CJTF) during a crisis or contingency operation. NIST is a nationally

[12] Joint Chiefs of Staff, Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations, Joint Pub 2-03, (Washington, DC: 31 March 1999), I-4.

sourced team composed of intelligence and communications experts from DIA, CIA, NIMA, NSA, or other intelligence community agencies as required. The NIST mission is to provide a tailored national-level all-source intelligence team to deployed commanders during crisis or contingency operations. NIST supports intelligence operations at the JTF headquarters and is traditionally collocated with the JTF J-2."[13]

The Problem with Doctrine

The expertise exists, but the employment of that expertise has been primarily focused at the tactical level. While the tactical level is important, the operational level also has much to gain from the inherent capabilities of GI&S. Joint doctrine should provide clear guidance on how GI&S should be employed, but it currently does not. For example, the checklist for Crisis Action Planning (CAP) contained in Joint Pub 5-00.2, Joint Task Force (JTF) Planning Guidance and Procedures, asks in Phase III, Course of Action Development, "What is the status of geospatial information and services support within the area?"[14] The checklist for the JTF J-2 asks simply, "Have requirements for all geospatial information and services support been identified? . . . Have JTF geospatial information and services shortfalls been identified?"[15] Determining status, requirements and shortfalls is an important task, but neither checklist suggests that GI&S should actually be *used* during CAP. The same omission occurs in deliberate planning doctrine.

In another instance, JTF Planning Guidance and Procedures doctrine recommends that the CJTF form a Joint Planning Group (JPG) to enhance the CAP process. The doctrine places GI&S in an Information Management Cell on one page, but in a subsequent diagram GI&S is replaced

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[13] Joint Chiefs of Staff, Doctrine for Intelligence Support to Joint Operations, Joint Pub 2-0, (Washington, DC: 9 March 2000), IV-6.

[14] Joint Chiefs of Staff, Joint Task Force (JTF) Planning Guidance and Procedures, Joint Pub 5-00.2, (Washington, DC: 13 January 1999), IX-34.

[15] Ibid., VI-18.

with the word "maps".[16] The interchangeable use of GI&S and maps clearly illustrates a fundamental misunderstanding of GI&S in this joint publication. The proper placement of GI&S expertise, in the JPG is in the planning cell supporting tasks like mission analysis, COA development and analysis, and branch and sequel planning. Until the specific role of GI&S in joint planning is better understood, both the CJTF's and J-2's checklist should simply ask "Is a GI&S expert present in the planning cell?"

On The Use of GI&S in Military Applications

GI&S has already proven itself in a number of military applications, from exercises, experiments and demonstrations to actual operations. This section will describe two of these successes, and suggest other opportunities where GI&S could play an important, if not critical role, in future military operations.

Demonstrated Successes

The most recent employment of GI&S in combat was during Operation ALLIED FORCE. To meet the challenges of this operation, NIMA devised a solution referred to as "NIMA-in-a-Box". The name reflected the manner in which the data, hardware and software were packaged. All the geospatial information over the area of interest was loaded onto a laptop with a COTS GIS application, ArcView (sold by ESRI). The geospatial data included maps, at scales ranging from 1:15K to 1:5M, elevation data, feature data, name, port and airfield databases and controlled imagery. The data all fit on the laptop's 25 gigabyte hard drive. The laptop was operated in stand-alone configurations or was connected to the SECRET Internet Protocol Router Network (SIPRNET) to receive periodic data updates. NIMA personnel deployed with the laptops, delivered and installed them at customer sites, and provide initial training to operators.

[16] Ibid, IX-8, IX-11.

NIMA-in-a-Box primarily supported tactical targeting functions during Operation ALLIED FORCE.[17] On the airborne battlefield command and control center (ABCCC) platform, it was used in a stand-alone configuration to support "flex" targeting. Geographic coordinates provided by the Combined Air Operations Center (CAOC) were typed into the laptop and the software drove to that location, centered on a 1:50K map background. A printout of the annotated map enabled controllers to talk pilots onto their targets. The ability to instantly locate positions by place name or coordinate was a significant improvement to the previous method of first finding the right map and then locating the feature or target manually.

When connected to the SIPRNET, imagery updates from several demand-driven direct digital dissemination (5D) file servers were downloaded and integrated with the geospatial data. The result was a point and click interface that linked geographic position with current imagery. This capability greatly assisted in the maintenance of target folders, a heretofore laborious, manual task. SIPRNET connectivity also enabled continual updates of geospatial data to the existing dataset.

The tactical success of NIMA-in-a-Box was the outcome of direct interaction between the people performing the mission and the GI&S experts supporting it. If NIMA had waited for the ABCCC battle captain to ask for a "NIMA-in-a-Box" capability, it never would have happened, because the product did not exist. Translating requirements into a tangible product or capability requires a mutual understanding of the mission and the current tools and technology available to support it.

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[17] More information on NIMA-in-a-Box can be found in the October, 1999 issue of Signal Magazine, in an article titled "Balkans serve as Proving Ground for Operational Imagery Support" by Robert K. Ackerman. This article is also available on-line at <http://www.us.net/signal/Archive/Oct99/balkans-oct.html>.

During the Joint Warrior Interoperability Demonstration 2000 (JWID00), NIMA expanded the NIMA-in-a-Box concept to a network-centric environment.[18] Using commercially available collaborative software (Microsoft NetMeeting) and a prototype web-based capability, ArcView Internet Map Server (ArcIMS), NIMA emulated support to a major, dual-theater, coalition crisis operation. Again, GI&S was primarily used to satisfy tactical requirements. That is somewhat to be expected, however, since the emphasis in JWID is on the interoperability of C4I technologies and their ability to support the warfighter, versus capabilities to support strategic or operational planning and decision making. However, the demonstration did prove that the technology exists today to share geospatial information in a collaborative, coalition environment, making geospatial expertise available, virtually, to anyone on the network.[19] This capability is a true force multiplier that is particularly well-suited to supporting distributed collaborative planning.

Opportunities

The contribution of GI&S to the operational level of warfare has tremendous potential. To date, the operational utility of GI&S has primarily been realized in the creation of tailored planning graphics with overlays of information ranging from orders of battle to strategic targets. While useful, this type of product barely scratches the surface of GI&S capabilities. As mentioned above, the deliberate and crisis action planning processes could benefit greatly from the capabilities of GI&S. Specifically, this benefit could be realized in the mission analysis, COA development and analysis and execution planning phases of the planning processes.

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[18] JWID is an annual Joint Chiefs of Staff (JCS) J6 sponsored demonstration of new Command, Control, Communications, Computer and Intelligence (C4I) technologies for the warfighter.

[19] The NIMA JWID After Action Report contains a detailed description of NIMA's participation in JWID2000. The report is available on-line at <http://osis.nima.mil/ipo/IPO.html>.

Another related process that could be facilitated by the integration of GI&S is the joint intelligence preparation of the battlespace. "Joint intelligence preparation of the battlespace (JIPB) is a continual process which enables joint force commanders (JFCs) and their staffs to visualize the full spectrum of adversary capabilities and potential courses of action (COAs) across all dimensions of the battlespace. . . . JIPB support to the operational level is concerned with analyzing the operational area, facilitating the flow of friendly forces in a timely manner, sustaining those forces, and then integrating tactical capabilities at the decisive time and place."[20] GI&S capabilities are ideally suited to supporting the JIPB task. Fusing and visualizing data in a spatially referenced framework is a core function of geographic information systems. It is important to remember that geospatial data is not just maps and imagery. Cultural features, weather, demographics, order of battle, transportation networks, and power grids are just a sample of other geospatial datasets. Predicting adversary courses of action, and determining one's own, could be greatly facilitated by conducting JIPB in a GI&S enabled environment. Including GI&S expertise in this process is the first step toward achieving that goal.

In Summary

Geospatial data includes any data referenced to a point on the Earth and can come from a wide variety of sources. Geospatial data becomes information when presented in the context of a spatially referenced framework. Annex M of existing OPLANS and CONPLANS lists the GI&S support required for that plan, and should include requirements for standard products as well as non-standard geospatial information and services. Additionally, it is imperative that metadata is understood to avoid drawing erroneous conclusions from the data.

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[20] Joint Chiefs of Staff, Joint Tactics, Techniques, and Procedures for Joint Intelligence Preparation of the Battlespace, Joint Pub 2-01.3, (Washington, DC: 24 May 2000), vii, I-7.

Advances in technology continue to improve the tools available to exploit geospatial data and information. The JMTK application on GCCS provides a limited capability to import and manipulate geospatial data and display it in the COP. NIMA's plans to fully commercialize JMTK by 2004 should result in a more capable tool, but it will be more complex to operate. Commercial GIS applications have tremendous capabilities to exploit geospatial data and should be available to the DoD whether they are DII COE compliant or not.

Technology alone is not sufficient to gain the advantage over an adversary. Knowing how to leverage that technology is the key. Both people and doctrine are part of that equation. With the expertise that currently exists, GI&S can support the operational commander through all phases of the planning process. However, that support will not happen unless the expertise is physically present. Until doctrine institutionalizes how GI&S can best be leveraged at the operational level, it will be incumbent upon the JTF Commander to request GI&S expertise be fully integrated with the planning process.

The potential of GI&S to support tactical level tasks has been successfully demonstrated in recent events including Operation ALLIED FORCE and JWID00. However, the potential contribution to operational level tasks has not yet been realized. Bringing this capability to fruition demands direct interaction between the people performing the mission and the GI&S expertise supporting it. Only in this way will critical capabilities be revealed and process improvements discovered.

Conclusion and Recommendations

The replacement of MC&G with GI&S throughout military doctrine was not the equivalent of changing "happy" to "glad". GI&S provides much more capability than MC&G, and offers tremendous potential to positively impact military operations today. Some of that

impact has already been realized at the tactical level, but the operational level has yet to reap the benefits. The components of GI&S are in place today to realize this potential, understanding how and where to leverage them is the challenge.

The best way to harvest the operational potential of GI&S is to fully integrate GI&S expertise with the deliberate and crisis action planning functions. Only in such synergistic environments will capabilities and requirements be reciprocally translated into useful, relevant knowledge. Specifically, a GI&S expert should be a member of the JTF's Joint Planning Group to support tasks like initial COA development and analysis during the CAP process. In the deliberate planning process, a GI&S expert should be part of the J-5 staff, facilitating the development of OPLANs and CONPLANs, and ensuring that Annex M accurately reflects the GI&S capabilities and requirements for those plans.

JIPB is another operational function that could benefit from the integration of GI&S expertise. The four basic steps of JIPB, defining the battlespace, describing the battlespace's effects, evaluating the adversary, and determining the adversary courses of action, could be readily accomplished in a GI&S enabled environment. Therefore, collocating GI&S expertise with the Intelligence Directorate (J-2) staffs that typically perform the JIPB function would also help to realize the operational potential of GI&S.

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